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ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Tuneable PTC effect in polymer-wax-carbon composite resistors

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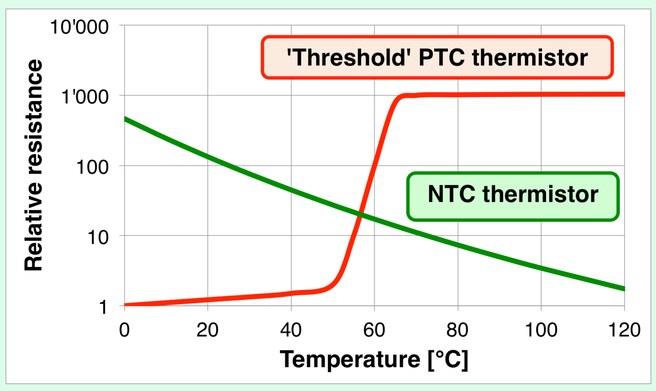
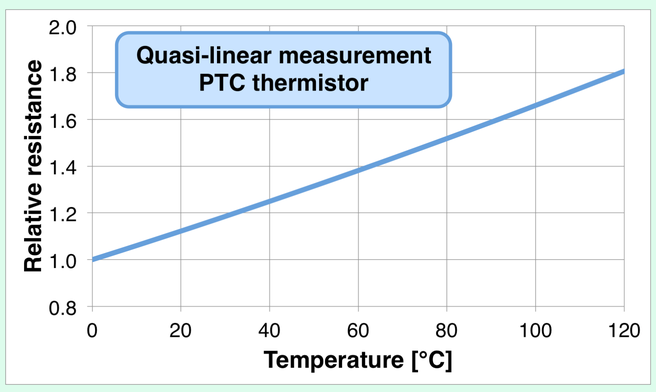
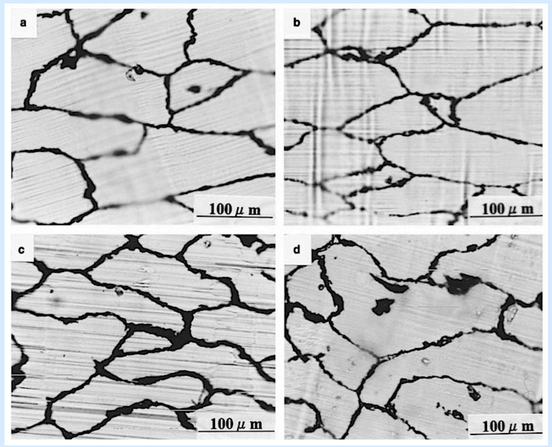
Thermistor types

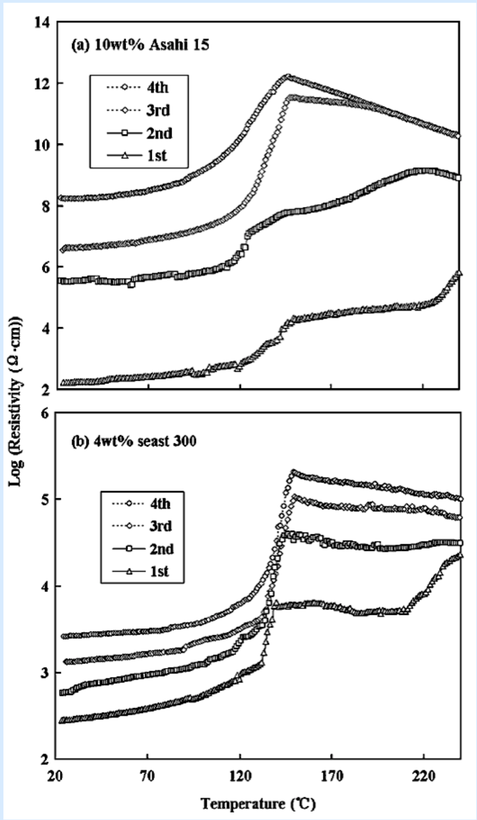




Common PTC type: PE - carbon



Zhang-C Ma-CA Wang-P Sumita-M, "Temperature dependence of electrical resistivity for carbon black filled ultra-high molecular weight polyethylene composites prepared by hot compaction", Carbon 43 (12), 2544-2553, 2005



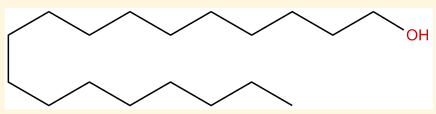
PTC effect linked to:

- Matrix continuous thermal expansion
- Matrix melting: expansion
- Matrix melting: filler rearrangement

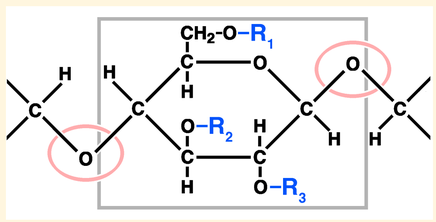
Goal: develop tuneable polymer-wax-filler system – 'hot-melt' type formulation

- One single polymer matrix – compatible with both bulk & screen printing for thick-film devices
- Transition temperature independently tuneable by wax melting point
- Carbon filler – here graphite (4 µm – TIMCAL KS4)

Binder & waxes



1-Octadecanol (wax)

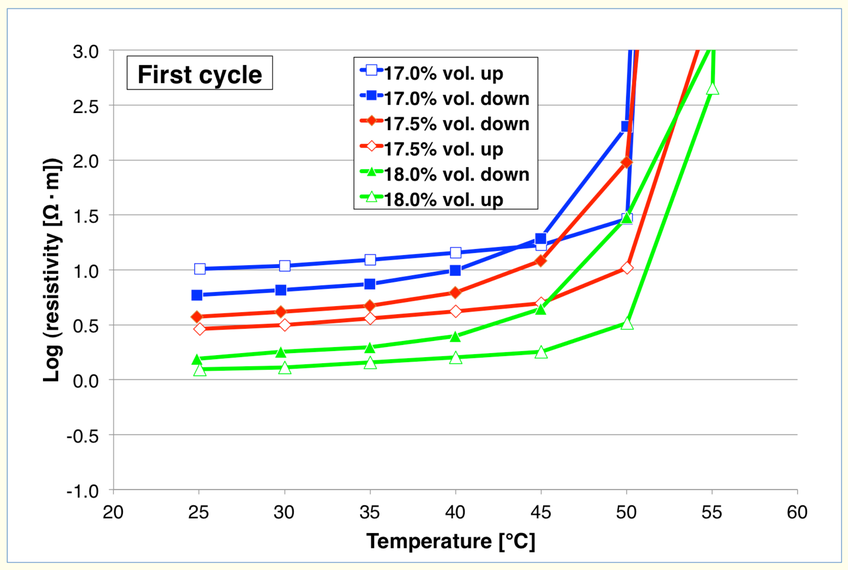


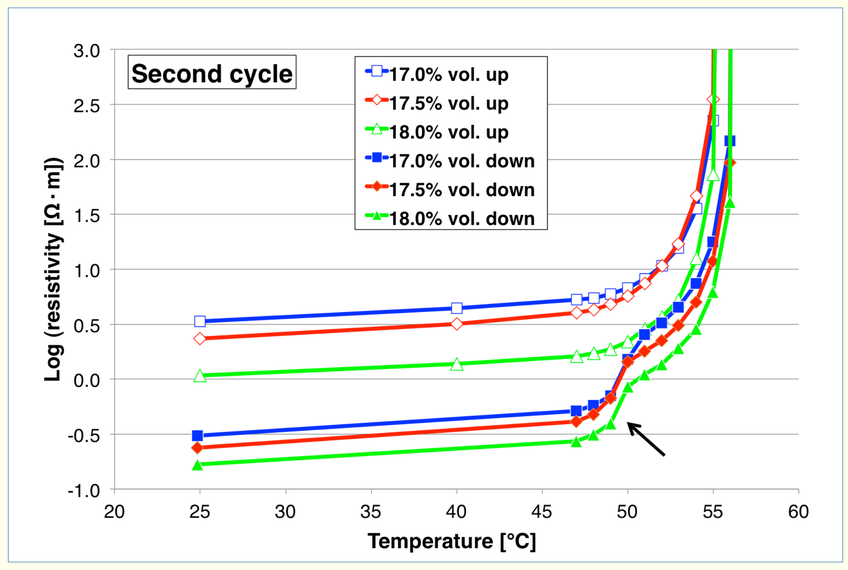
Ethylcellulose (binder polymer)

Code	Description	Melting point	Solubility for EC above M.P.	Crystallisation from EC at low temperature
So-16	Sorbitan monostearate / hexadecanoate	48°C	Yes	Yes (soft)
C18E2	Brij-S2 ; diethylene glycol octadecyl / stearyl ether	44°C	Yes	Yes (soft)
C14E0	Myristyl alcohol / tetradecanol	38°C	Yes	Yes (soft)
C16E0	Cetanol / hexadecanol	49°C	Yes	Yes
C18E0	**Stearyl alcohol / octadecanol**	**59°C**	**Yes**	**Yes (hard)**
TBz	Tribenzoin / Glyceryl tribenzoate	75°C	Yes (viscous)	No / slow (?)

Some possible waxes

Results





Conclusions & outlook

- PTC effect observed
- Transition ≈ wax M.P.
- Delayed effects
- Further studies needed with more systems